

# Arctic smoke

**Andreas Stohl**

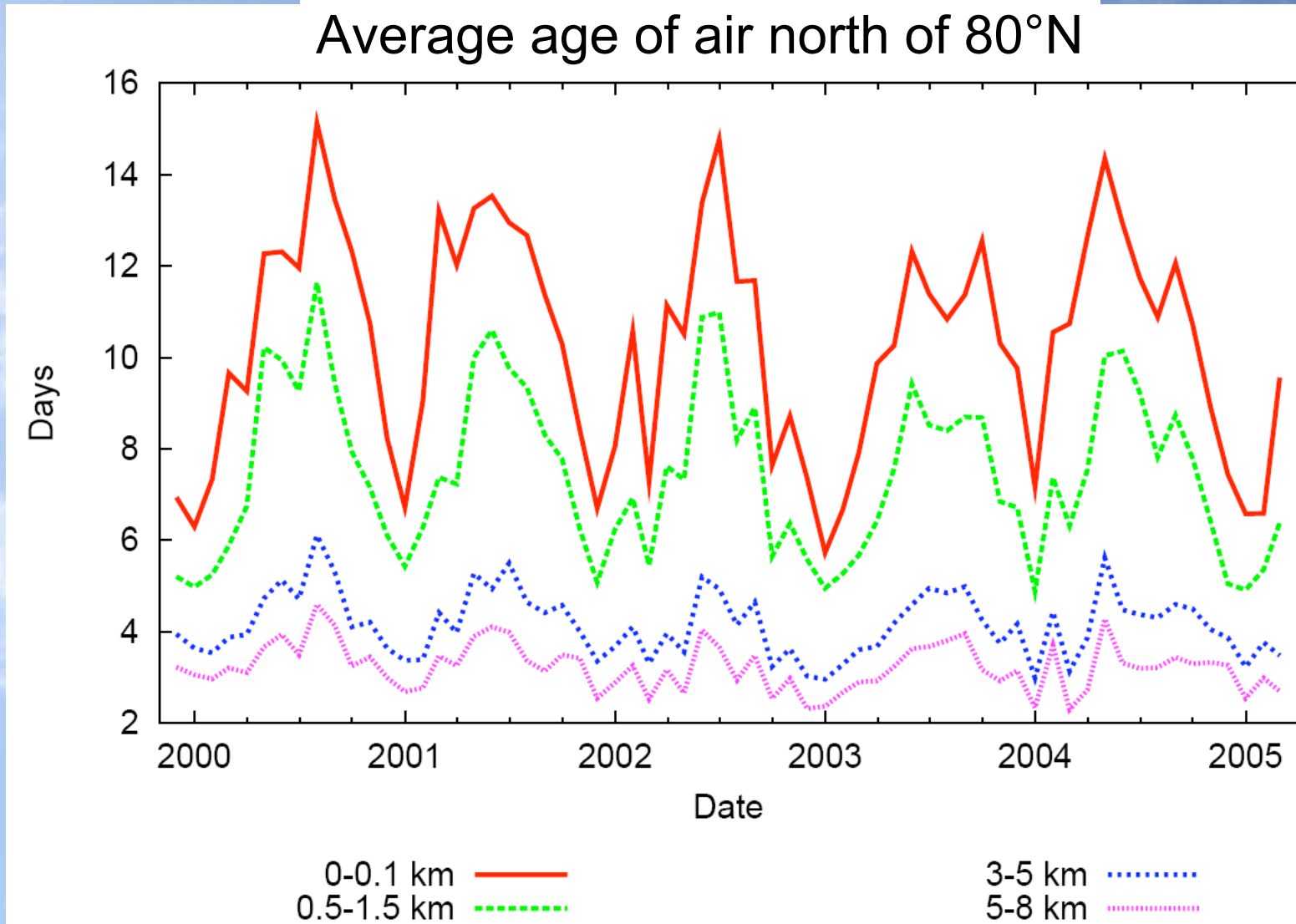
**Norwegian Institute for Air Research (NILU)**

**and**

**E. Andrews, T. Berg, J. F. Burkhardt, A. M. Fjæraa, C. Forster, A. Herber, S. Hoch, Ø. Hov, D. Kowal, C. Lunder, T. Mefford, W. W. McMillan, J. A. Ogren, S. Oltmans, S. Sharma, M. Shiobara, D. Simpson, S. Solberg, N. Spichtinger, K. Stebel, R. Stone, J. Ström, R. Treffeisen, K. Tørseth, K. Virkkunen, C. Wehrli, and K. E. Yttri**

# The Arctic age of air

Stohl (2006): Characteristics of atmospheric transport into the Arctic troposphere.  
*J. Geophys. Res.* **111**, D11306, doi:10.1029/2005JD006888.



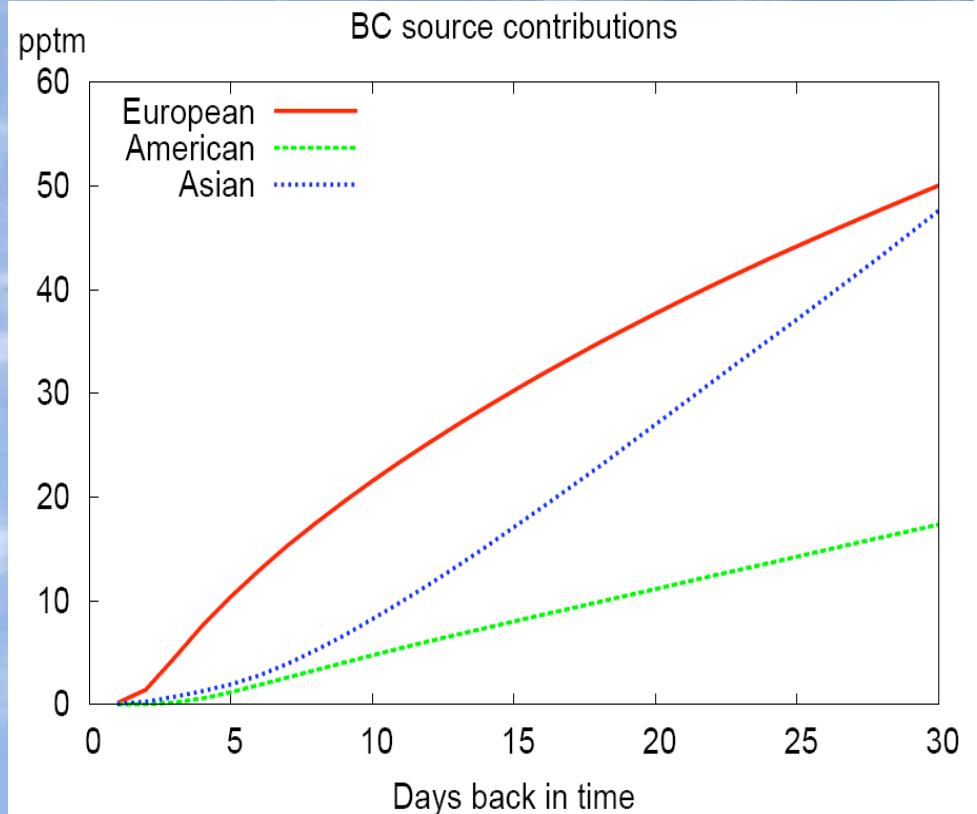
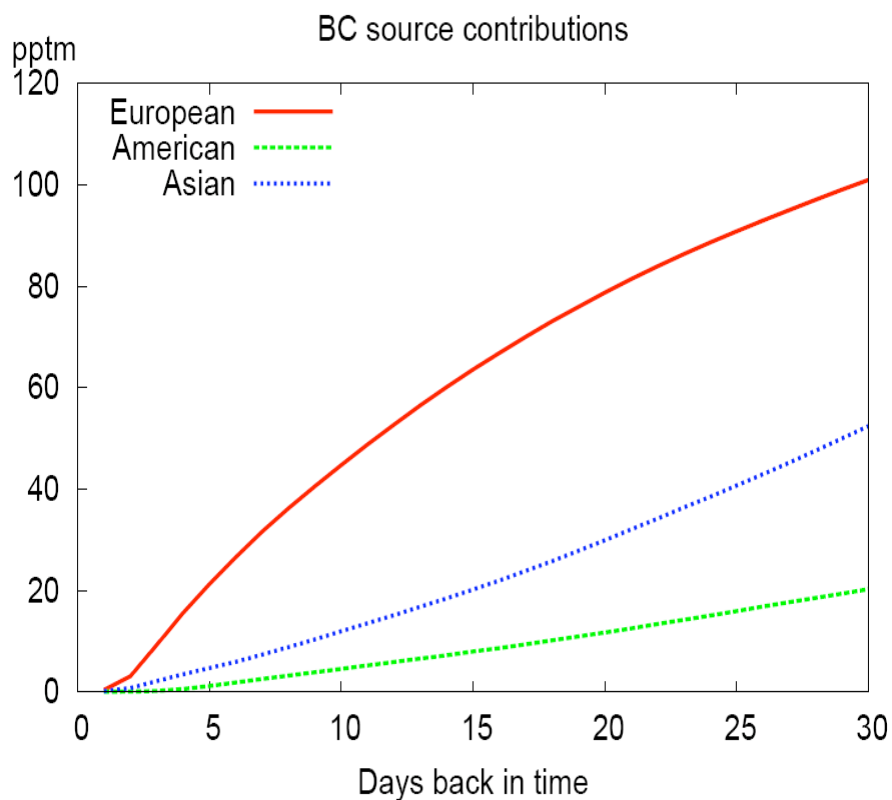
# Winter-time transport to the Arctic troposphere

Continental BC contributions in dependence of time from a FLEXPART tracer model simulation

– no chemistry, no removal, only transport using BC emission inventory from T. Bond

Lower troposphere

Total column

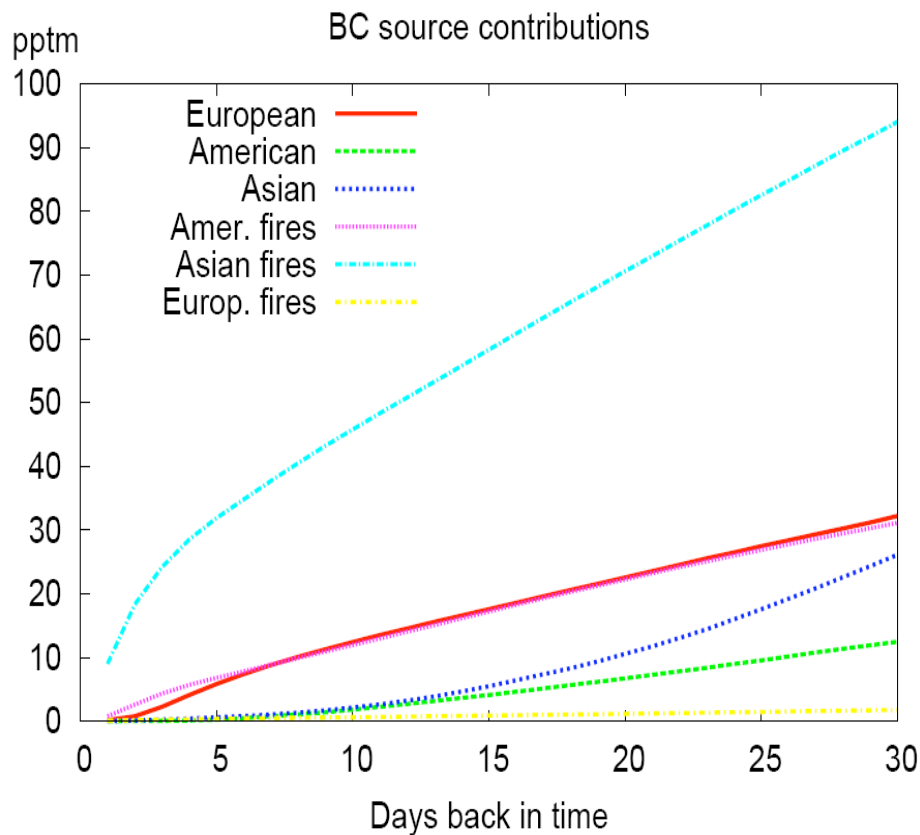


# Summer-time transport to the Arctic troposphere

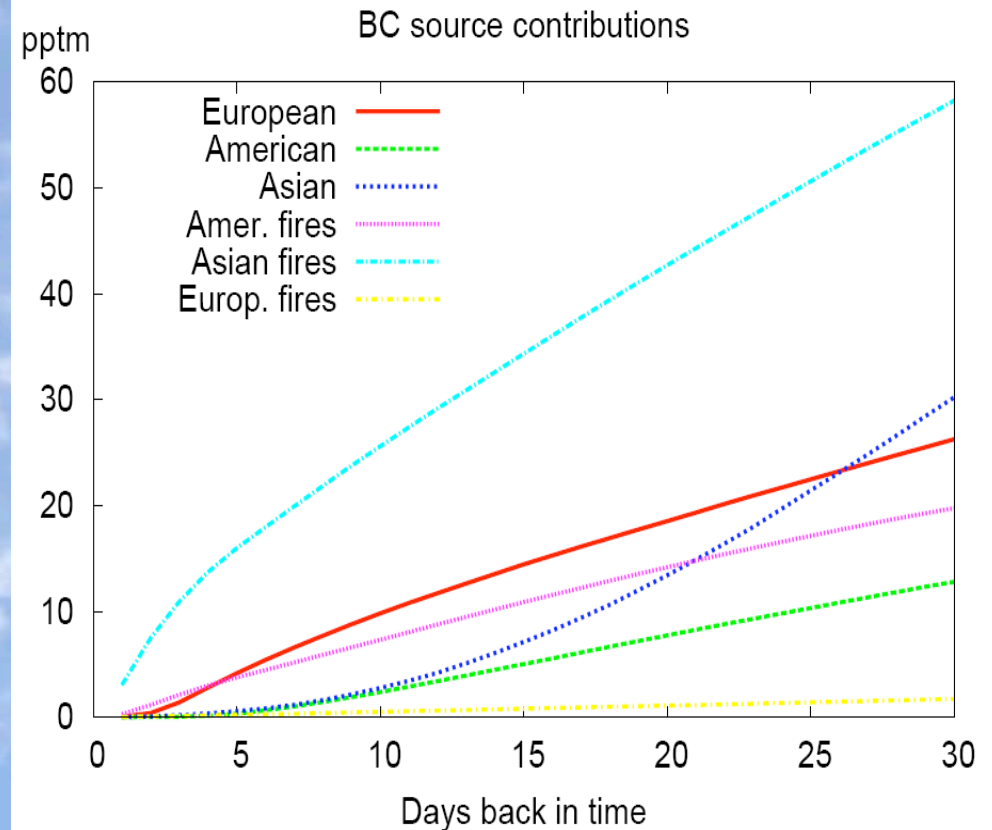
Continental BC contributions in dependence of time

BC inventories from T. Bond and D. Lavoue (boreal fires)

Lower troposphere



Total column



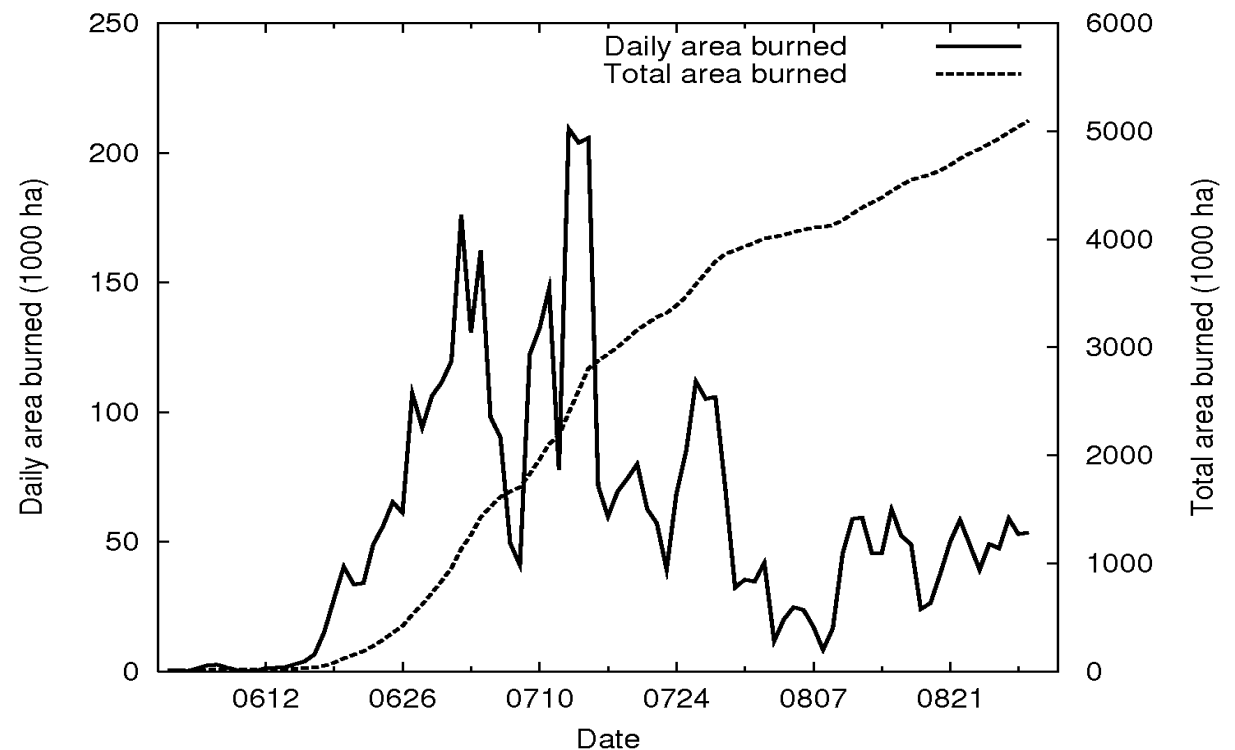
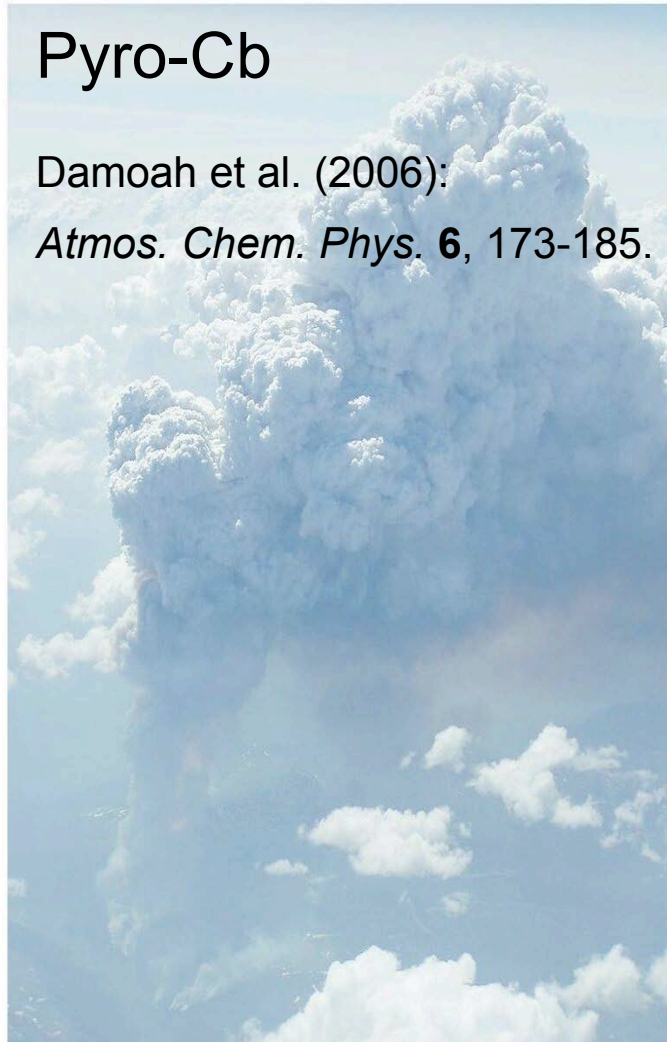
# Pan-Arctic enhancements of light absorbing aerosol concentrations due to North American boreal forest fires during summer 2004

Stohl et al. (2006): JGR, **111**, D22214,  
doi:10.1029/2006JD007216.

- 2004 was the most severe burning season in Alaska
- Strong fires also in western Canada
- > 5 million hectare burned

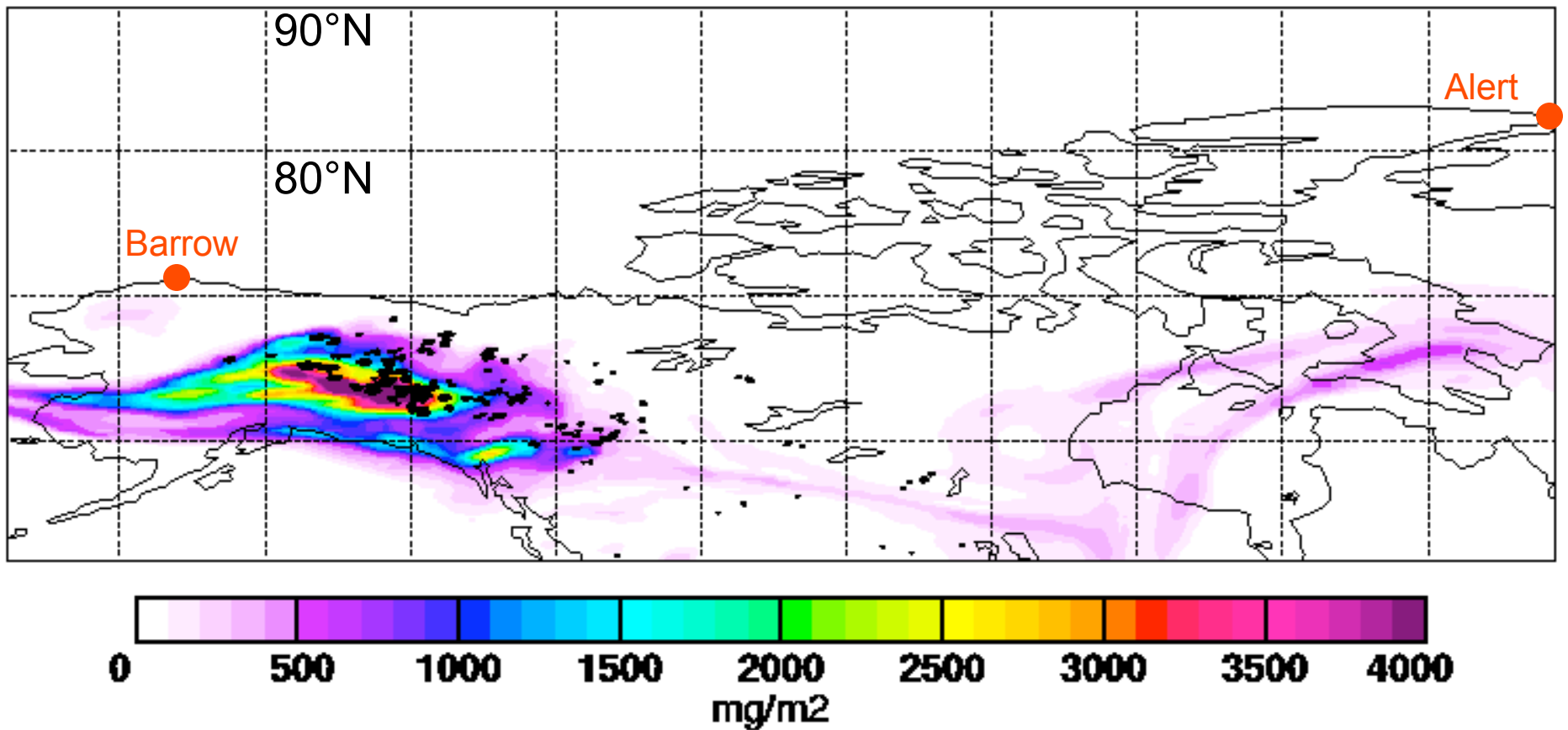
## Pyro-Cb

Damoah et al. (2006):  
*Atmos. Chem. Phys.* **6**, 173-185.



# FLEXPART Tracer Simulation: Total CO column

Actual time 20040629.120000

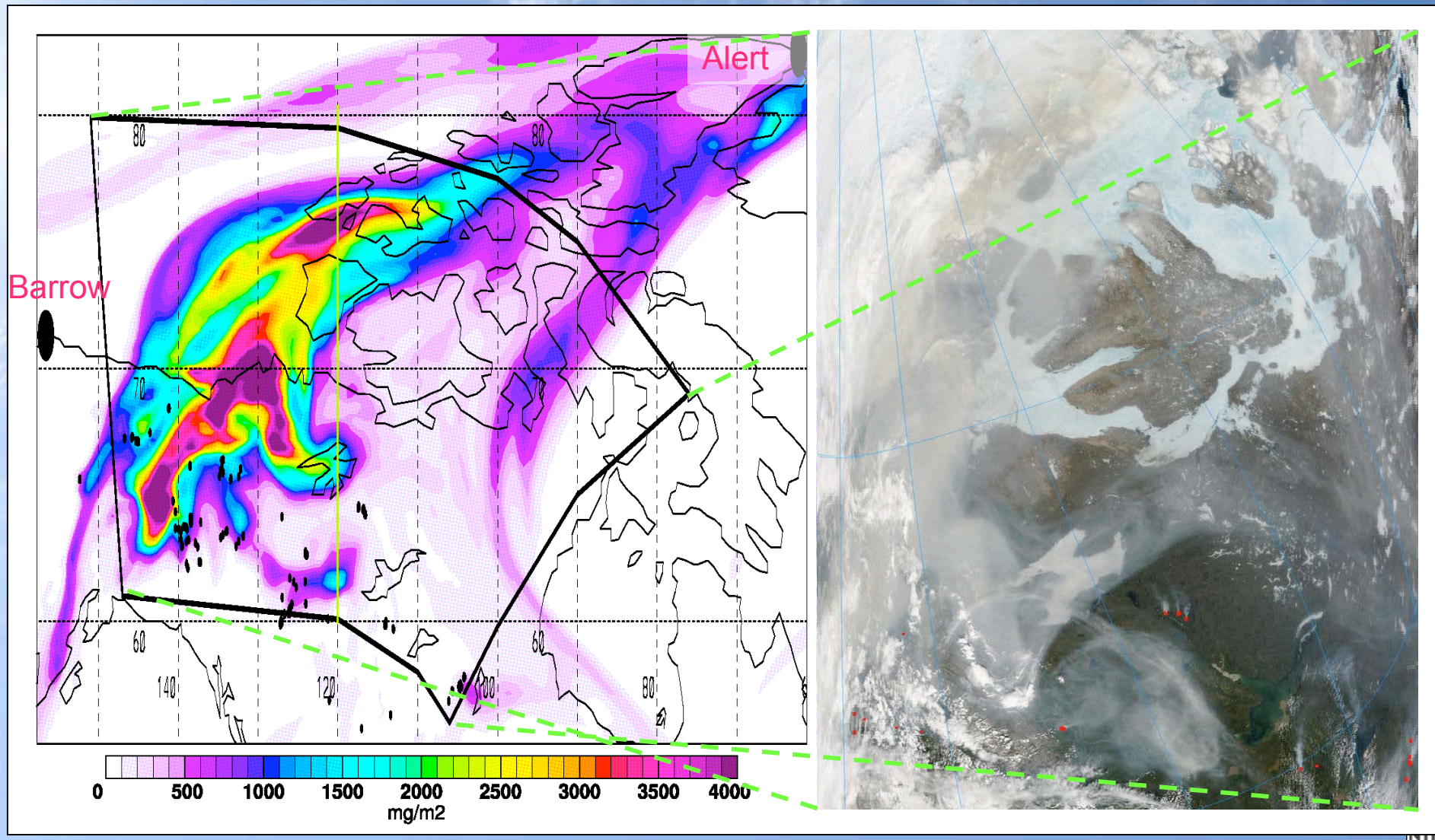


# Comparison model / satellite image

5. July 2004

FLEXPART Total Column

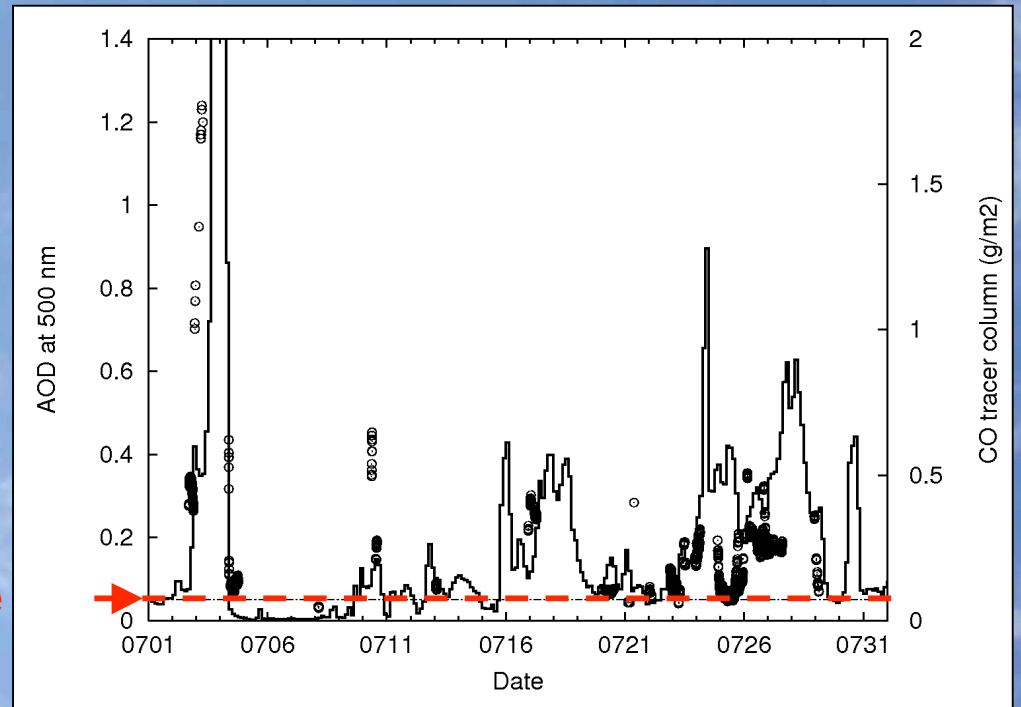
MODIS satellite image



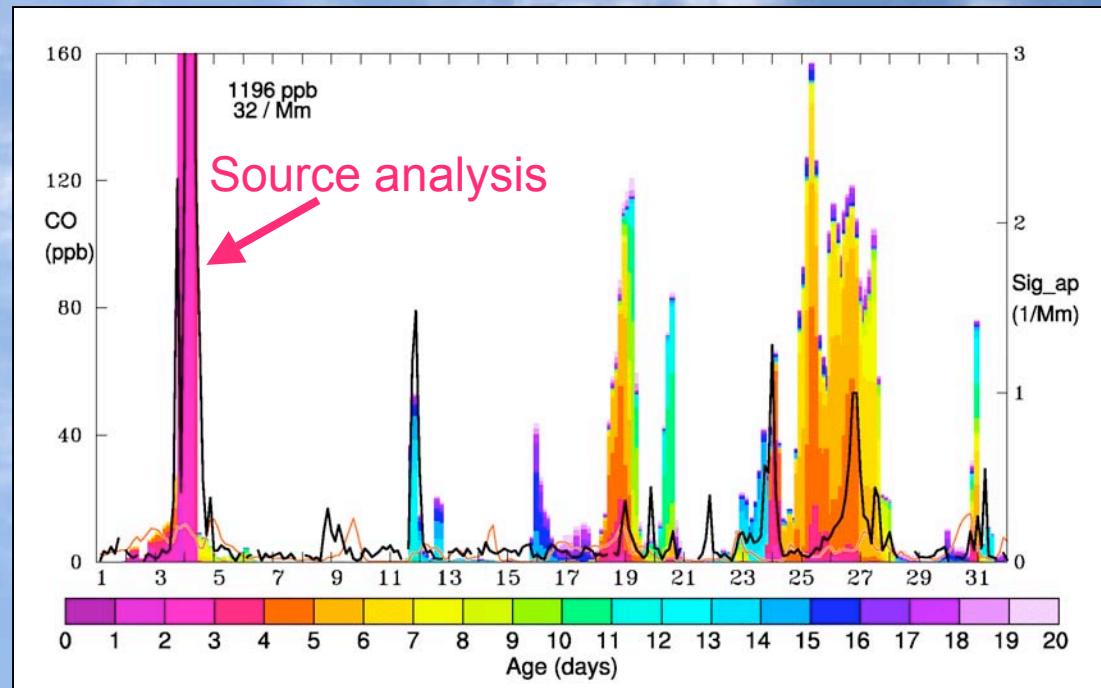
# Barrow, Alaska

- Aerosol Optical Depth (AOD) measurements (symbols) and FLEXPART CO column (line)

"normal" value



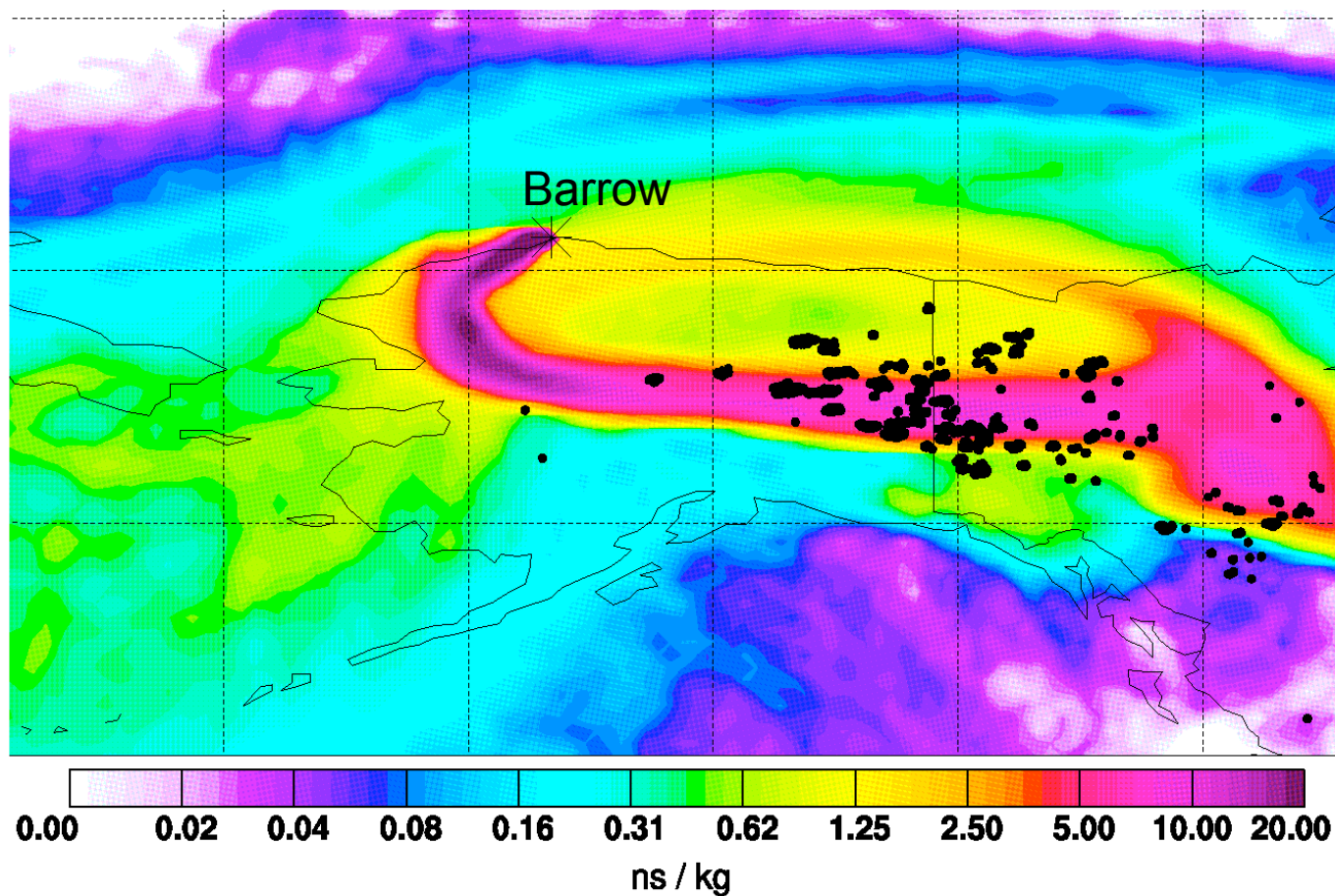
- EBC measurements (black line) and FLEXPART CO tracer at the surface (colors give the "age" since emission)



# Barrow, Alaska

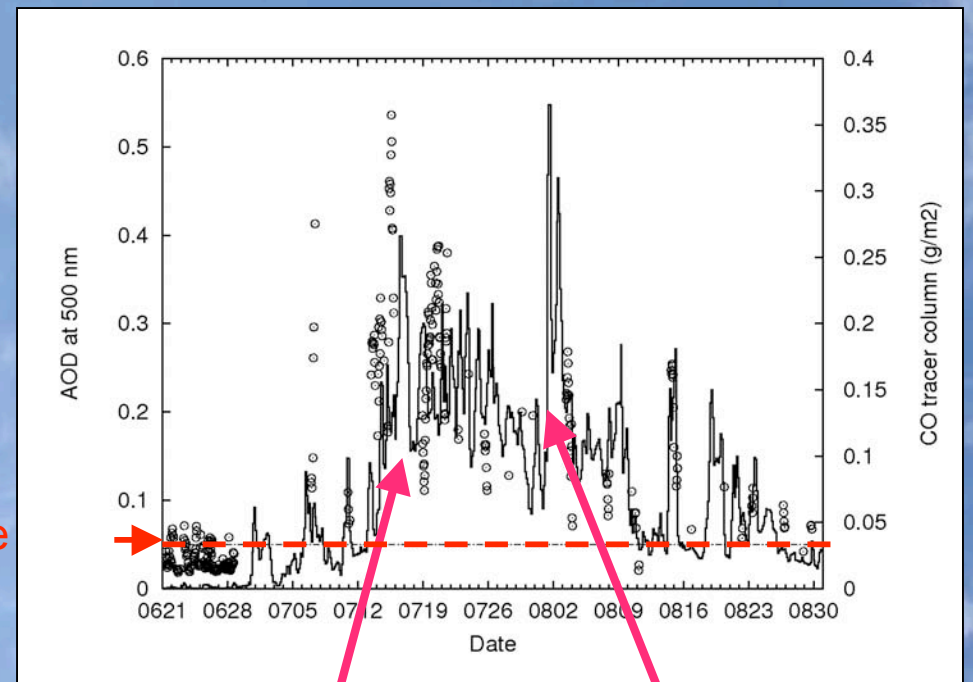
Source analysis  
using a FLEXPART backward calculation

## Emission sensitivity

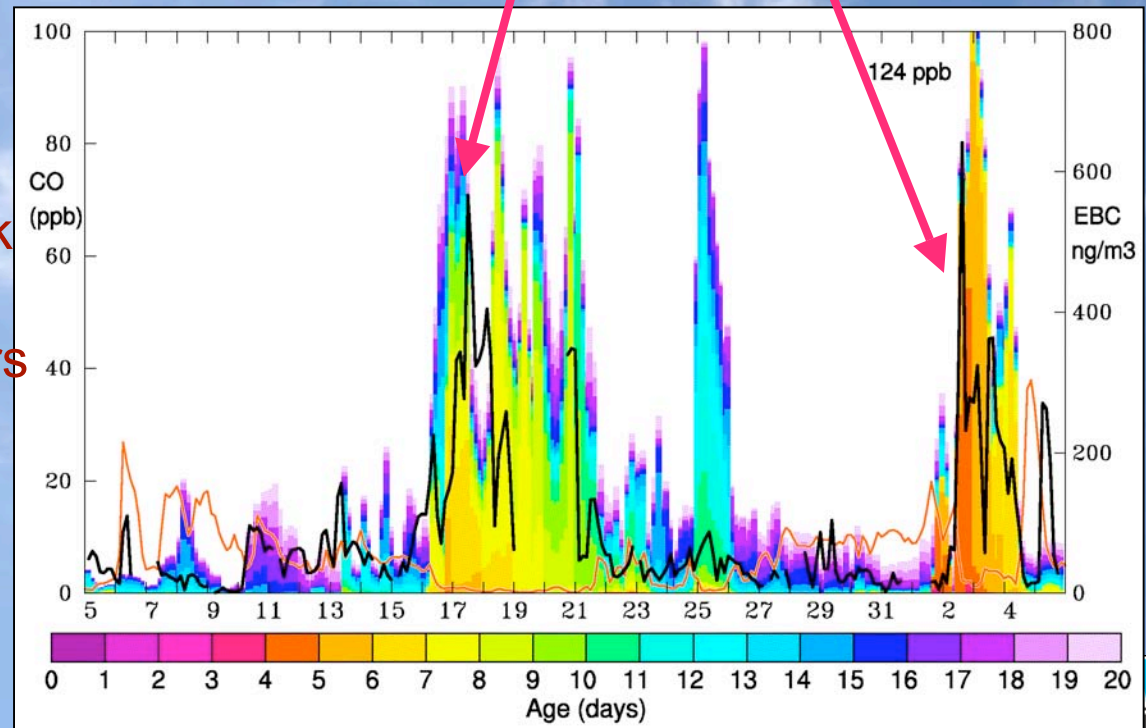


# Summit, Greenland

- Aerosol Optical Depth (AOD) measurements (symbols) and FLEXPART CO column (line)  
"normal" value

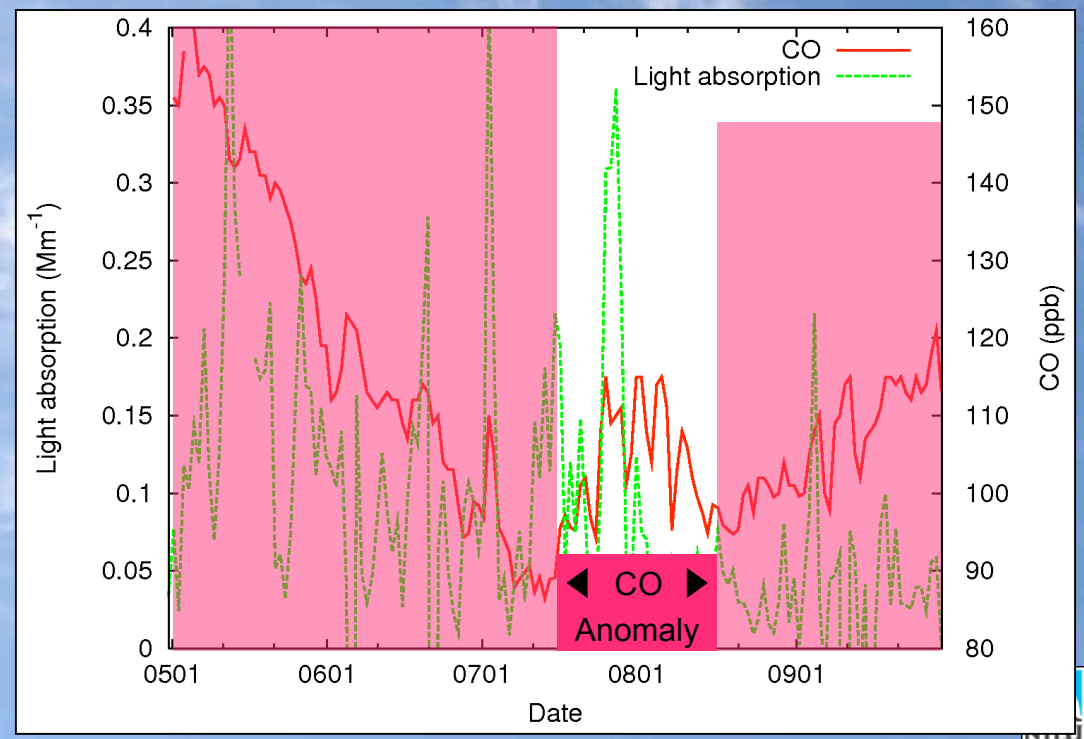


- EBC measurements (black line) and FLEXPART CO tracer at the surface (colors give the "age" since emission)



# Zeppelin, Spitsbergen

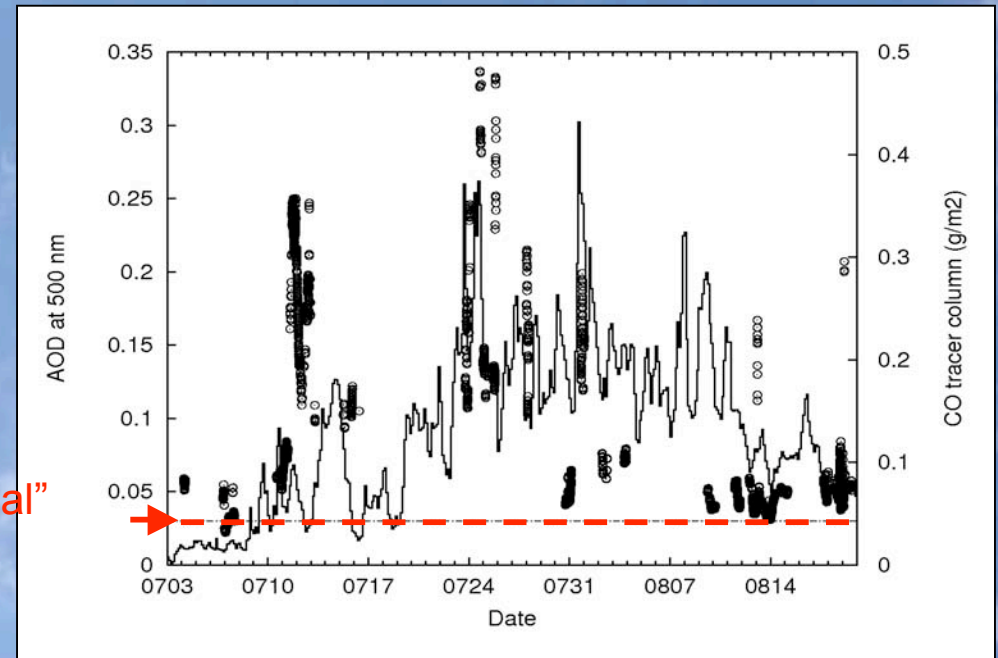
- CO and EBC measurements from May til September



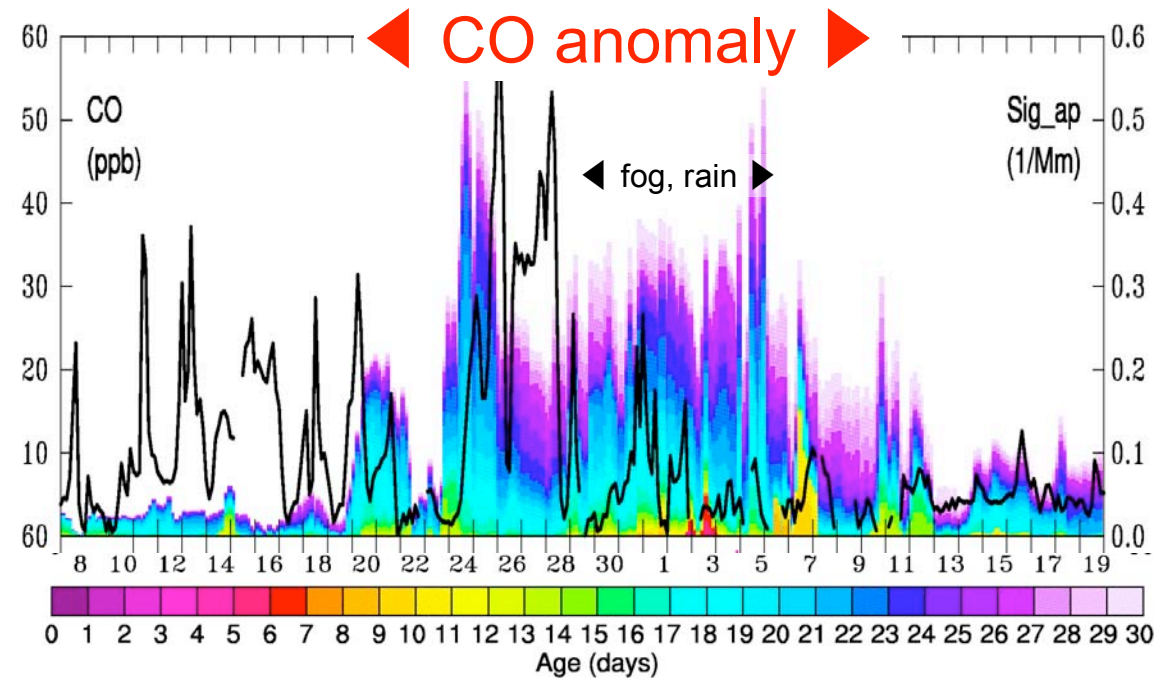
# Zeppelin, Spitsbergen

- Aerosol Optical Depth (AOD)-measurements (symbols) and FLEXPART CO column (line)

"normal"  
value

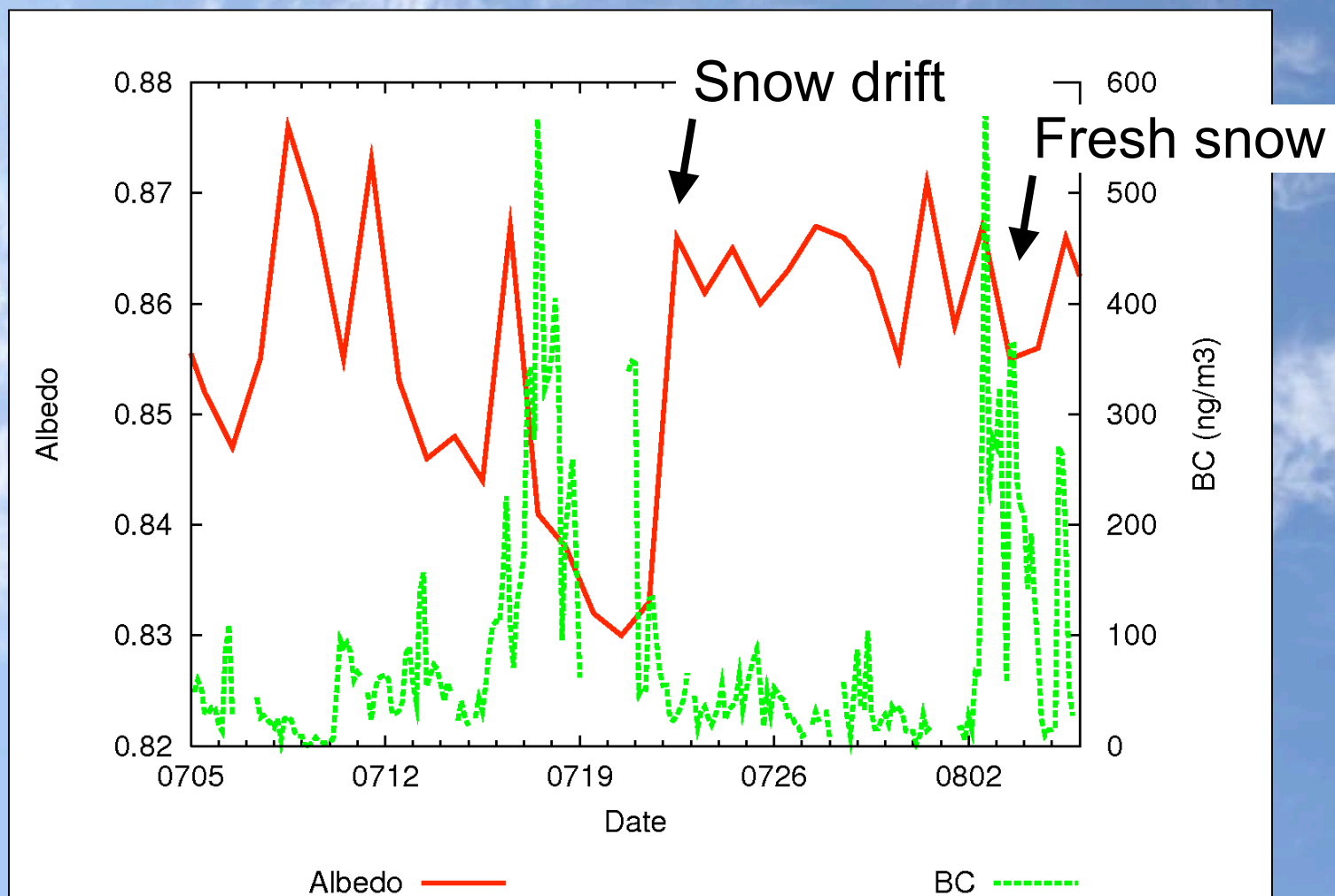


- EBC measurements (black line) and FLEXPART CO tracer at the surface (colors give the "age" since emission)



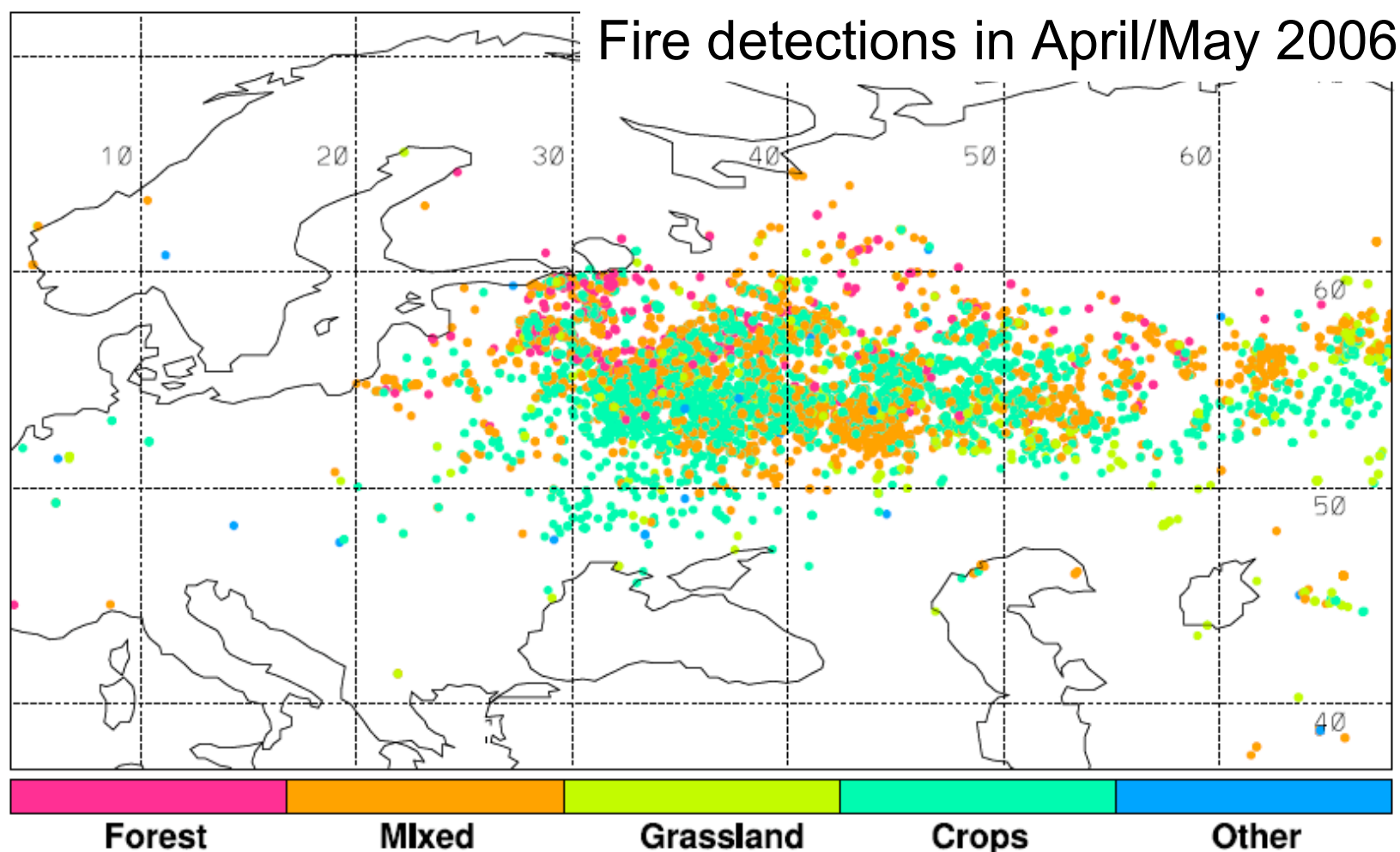
# Effects on the albedo of snow

## Albedo at Summit, Greenland

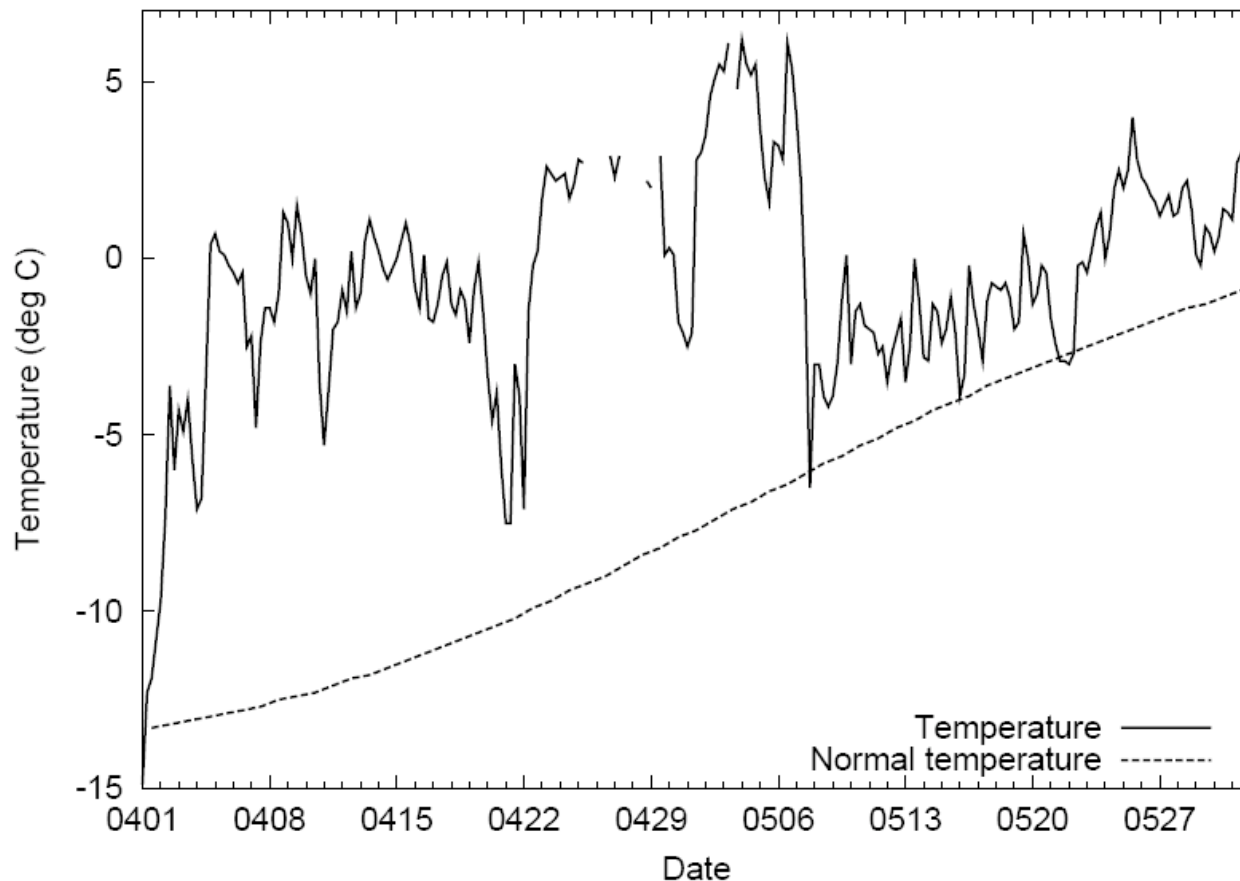


# Arctic smoke – record high air pollution levels in the European Arctic due to agricultural fires in Eastern Europe

Stohl et al. (2006): *Atmos. Chem. Phys. Discuss.* **6**, 9655–9722.



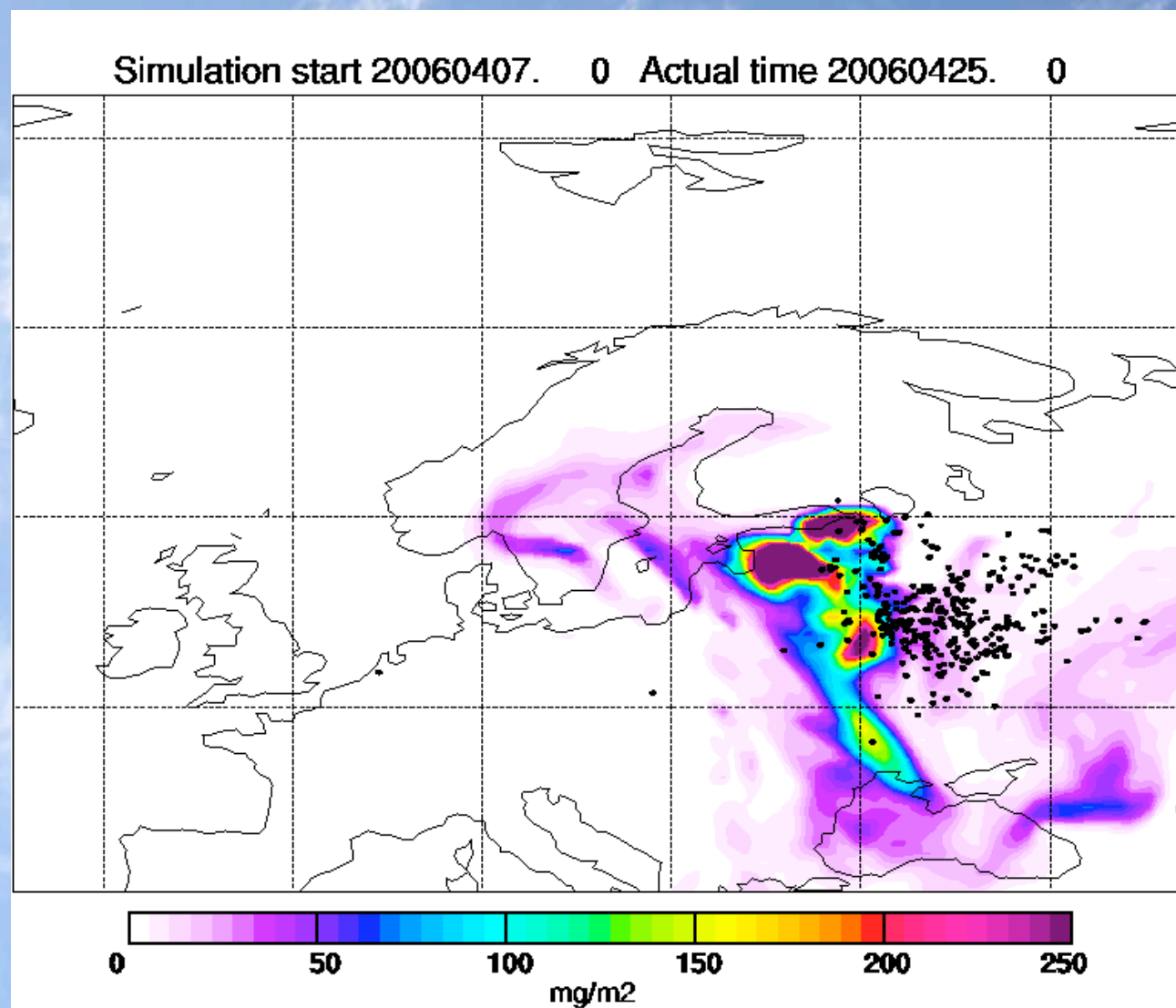
# Record warmth in the European Arctic



Temperature at  
Ny Ålesund,  
Spitsbergen in  
April and May  
2006

Warmth  
"dismantles" the  
polar dome and  
creates effective  
pathway into the  
Arctic!

# Transport of fire emissions into the European Arctic



# Extreme pollution



Picture courtesy: Ann-Christine Engvall

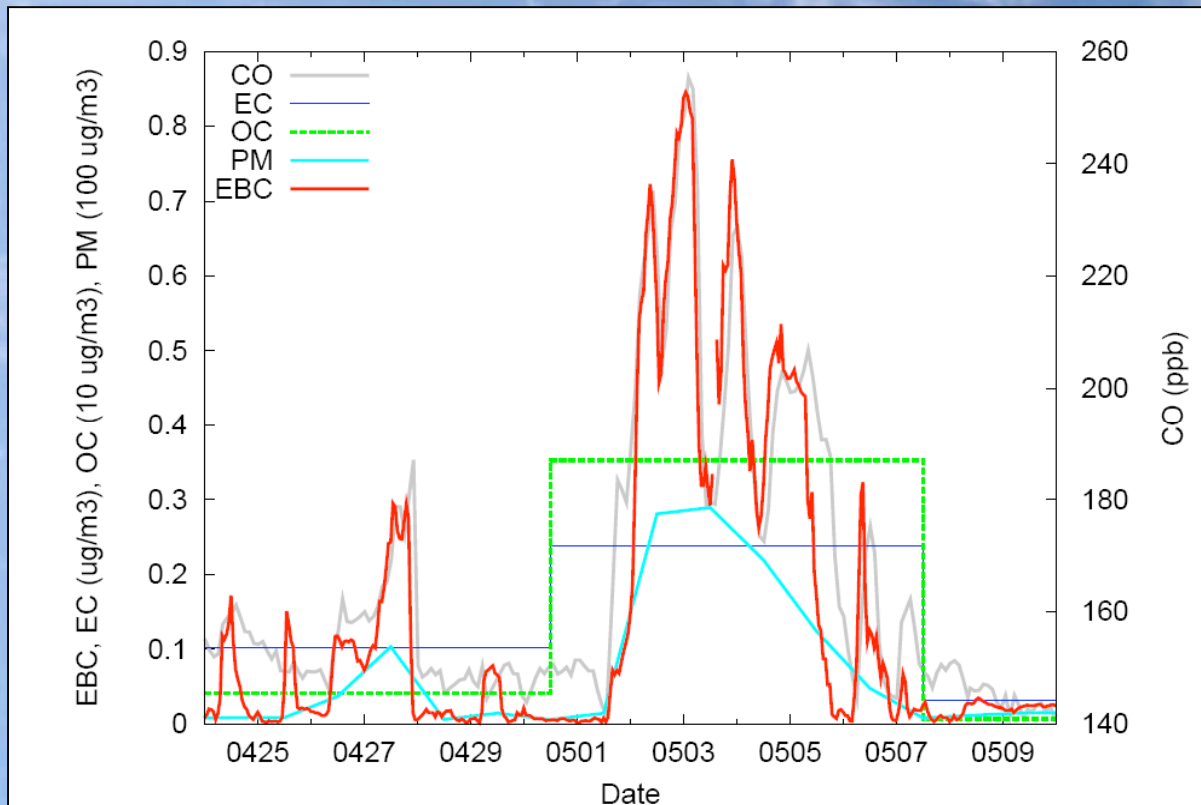
# Extreme pollution

At Zeppelin, new records were set for practically all measured compounds

Ozone, aerosol optical depth (both measured for about 15 years!)

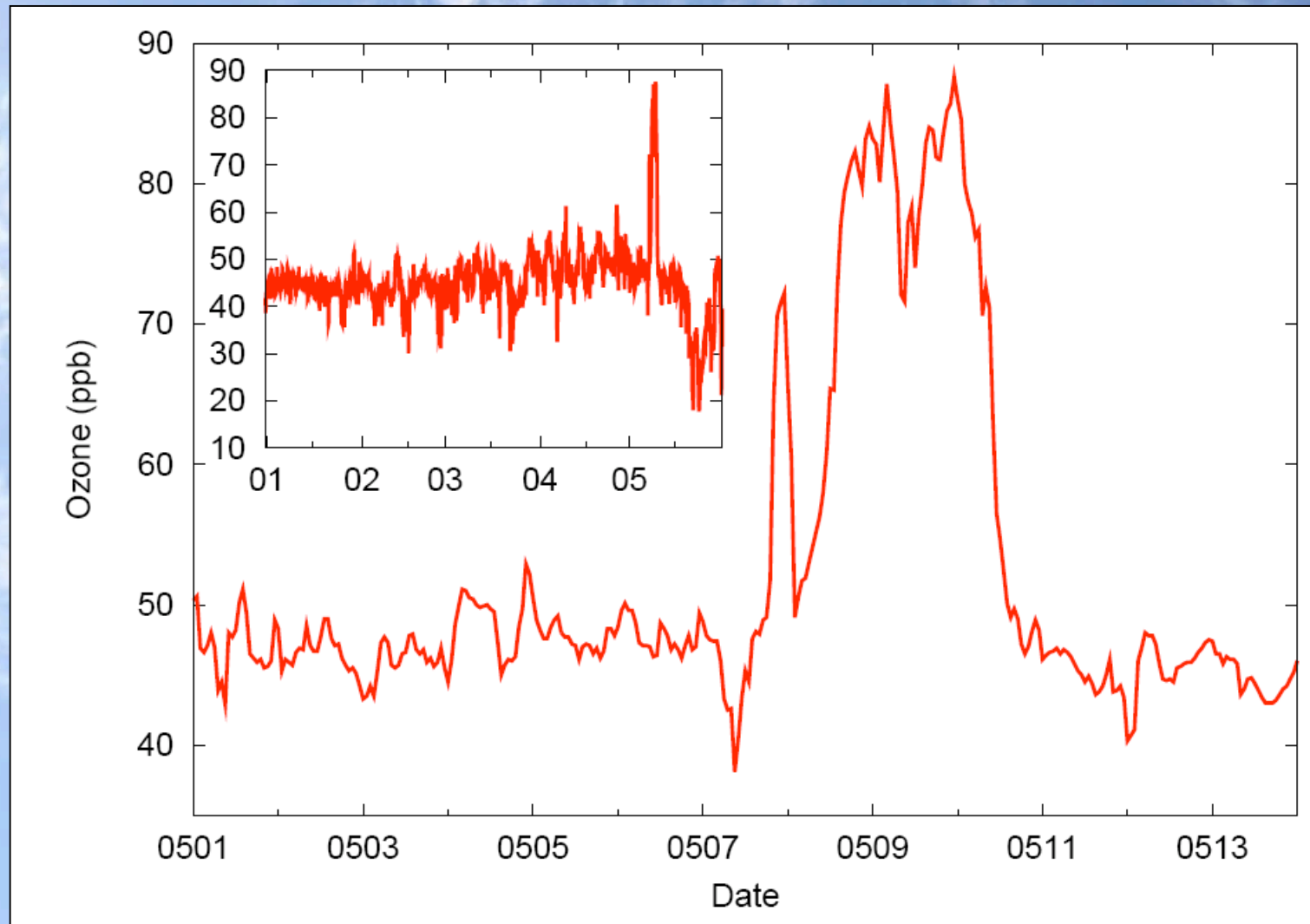
Carbon monoxide, particulate matter, etc.

Ozone formation was highly efficient!

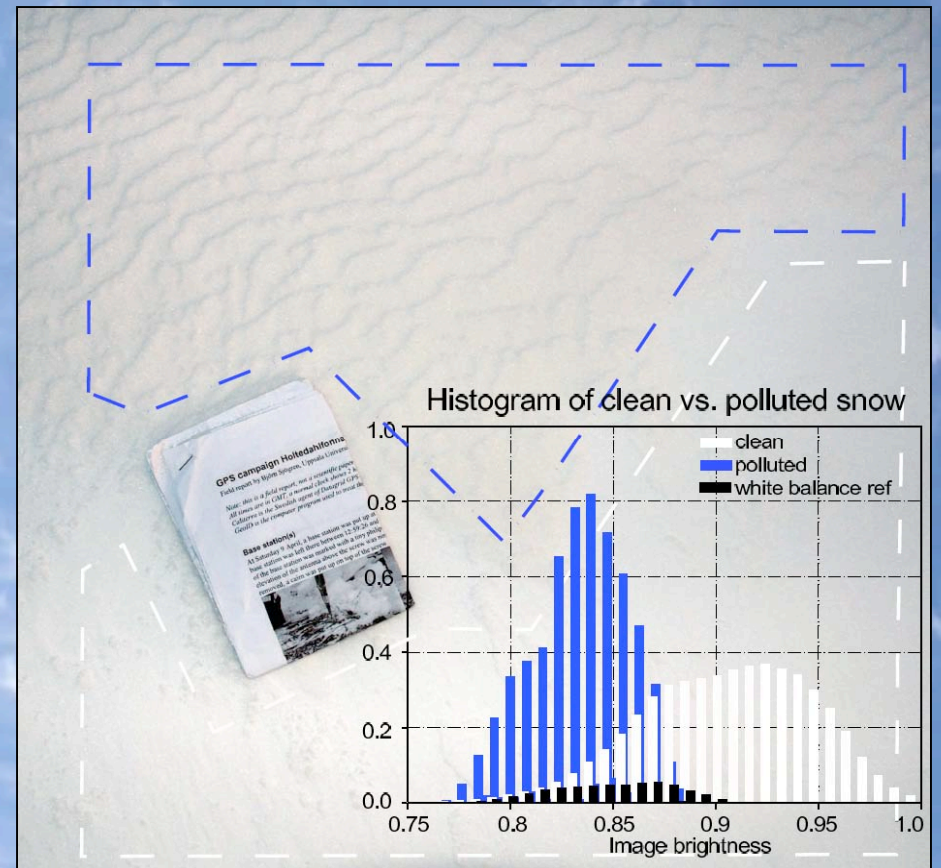


# Extreme pollution

At Iceland, a new ozone record was set, 15 ppb higher than any previously measured value



# Polluted snow at Holtedahlfonna observed by John Burkhardt



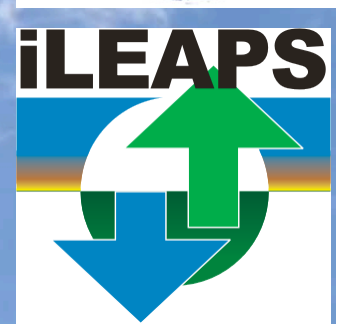
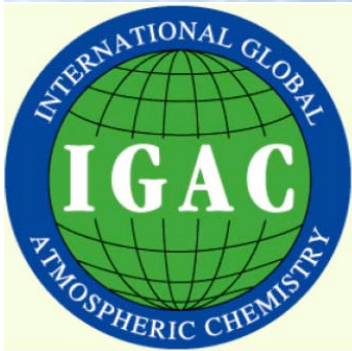
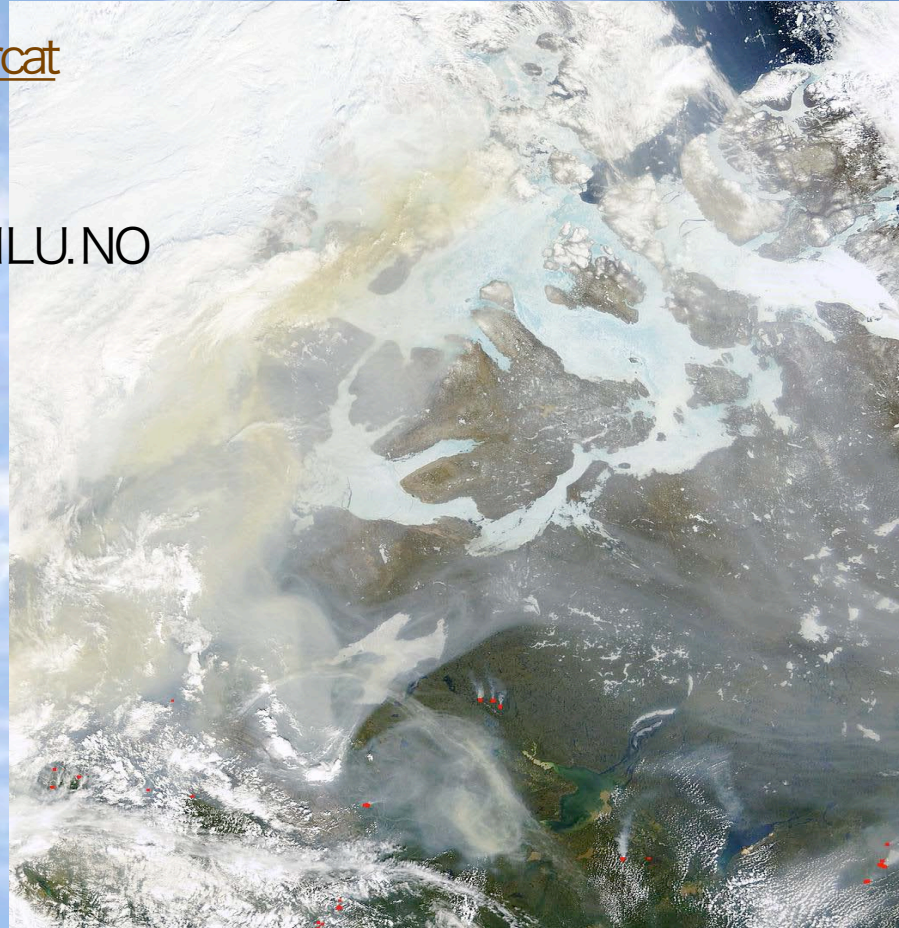
Ion chromatographic analysis of  
snow samples confirms BB source.

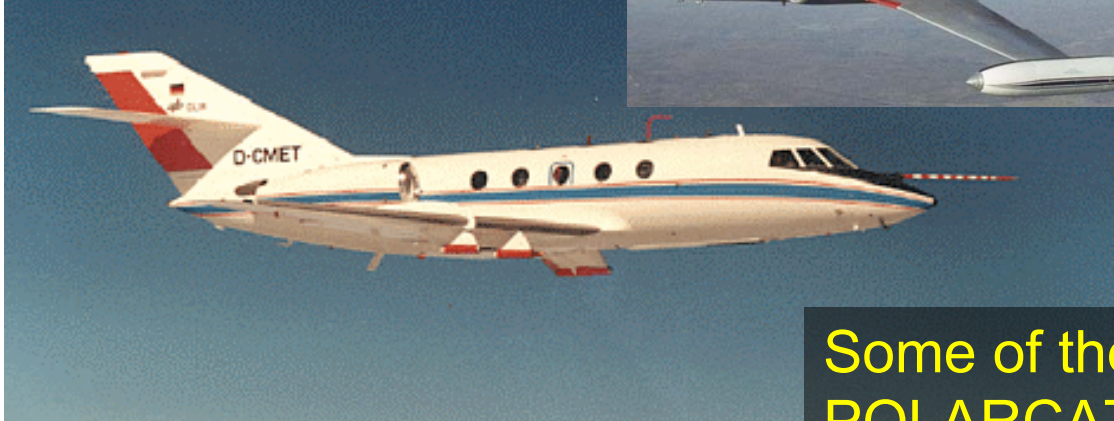
# POLARCAT

Polar Study using Aircraft, Remote Sensing, Surface Measurements  
and Models, of  
Climate, Chemistry, Aerosols, and Transport

<http://www.nilu.no/polarcat>

Contact me: AST@NILU.NO





Some of the  
POLARCAT  
platforms ....

